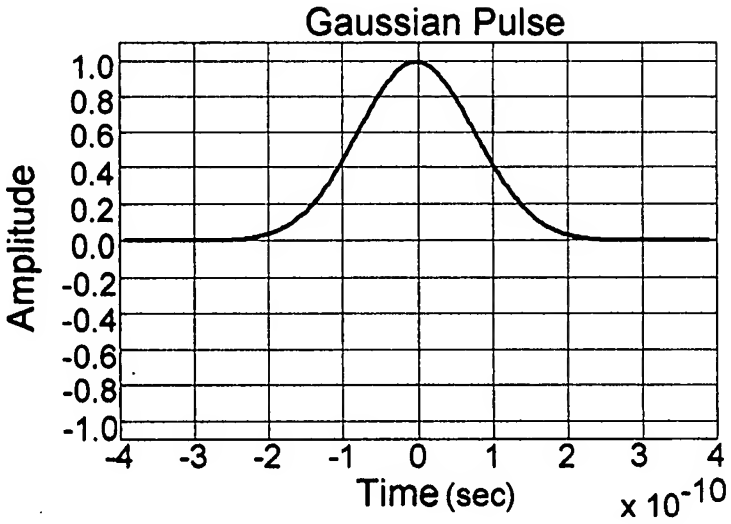


FIG. 1A

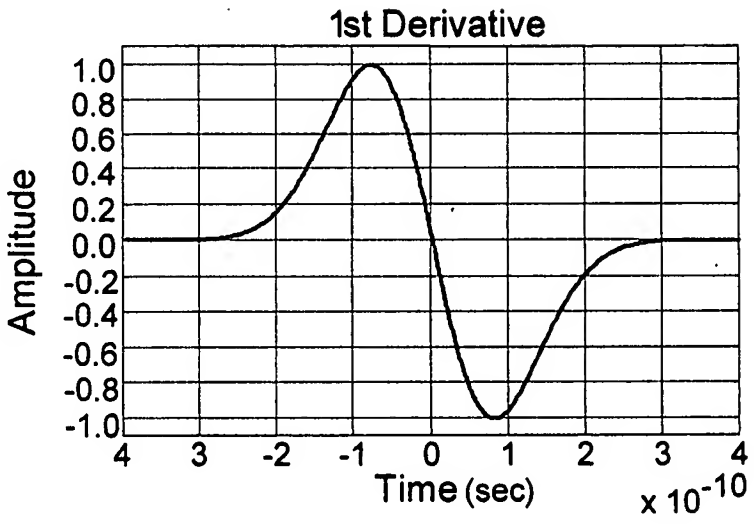


FIG. 1B

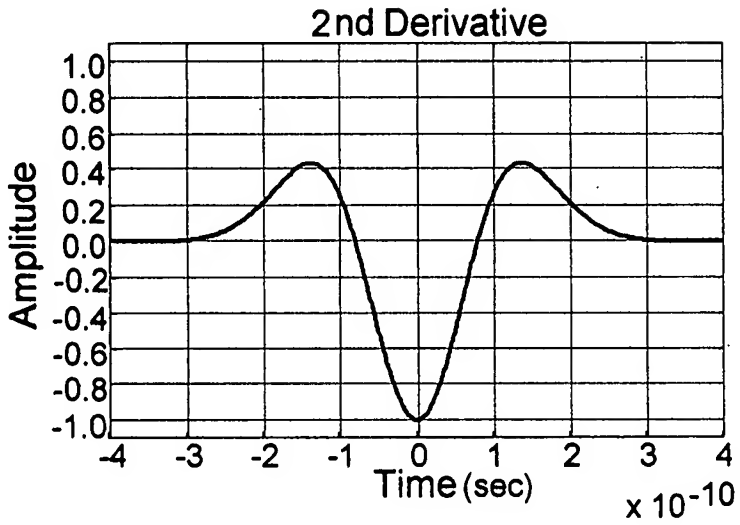


FIG. 1C

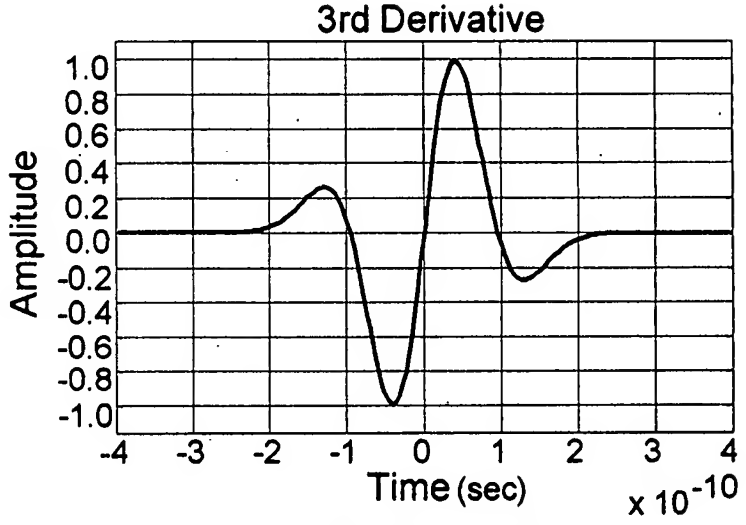


FIG. 1D

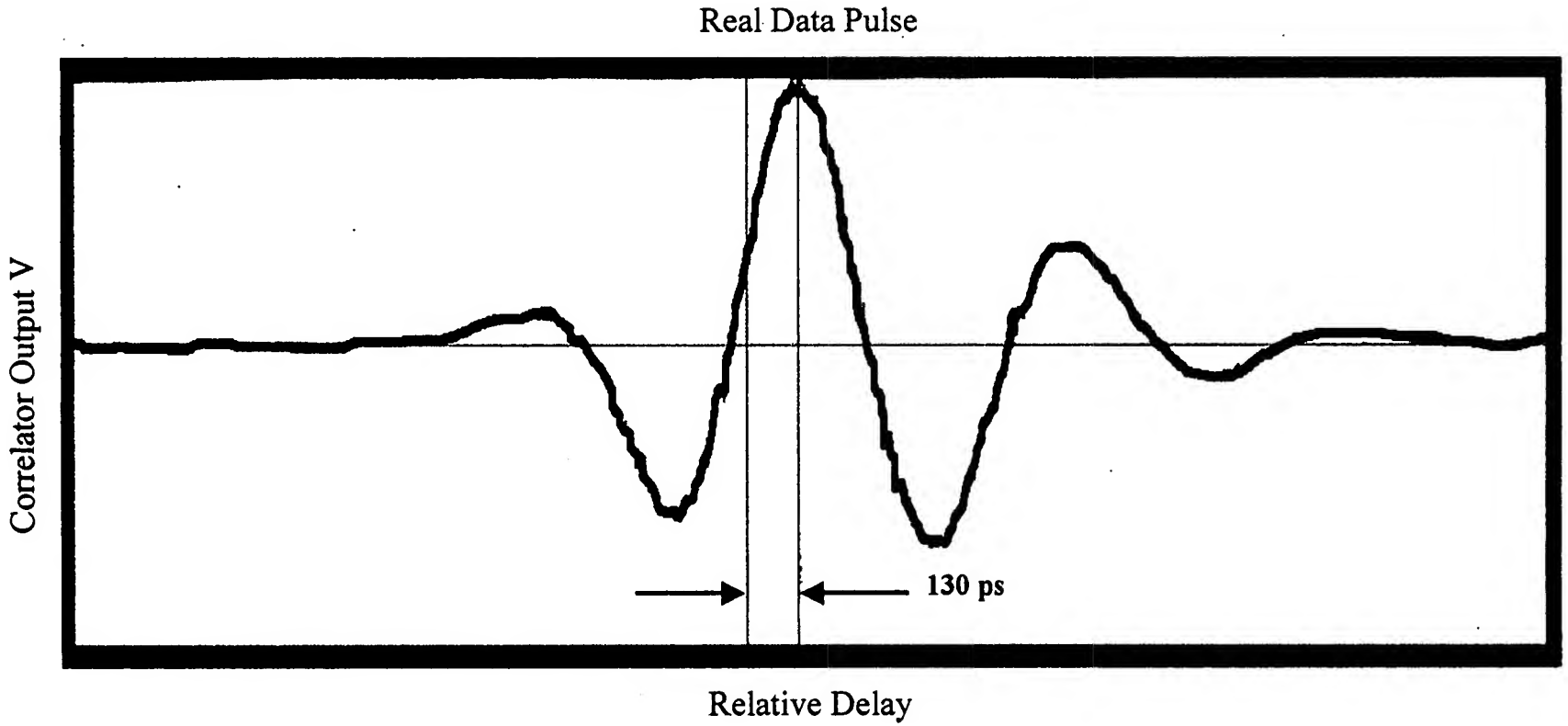


FIG. 1E

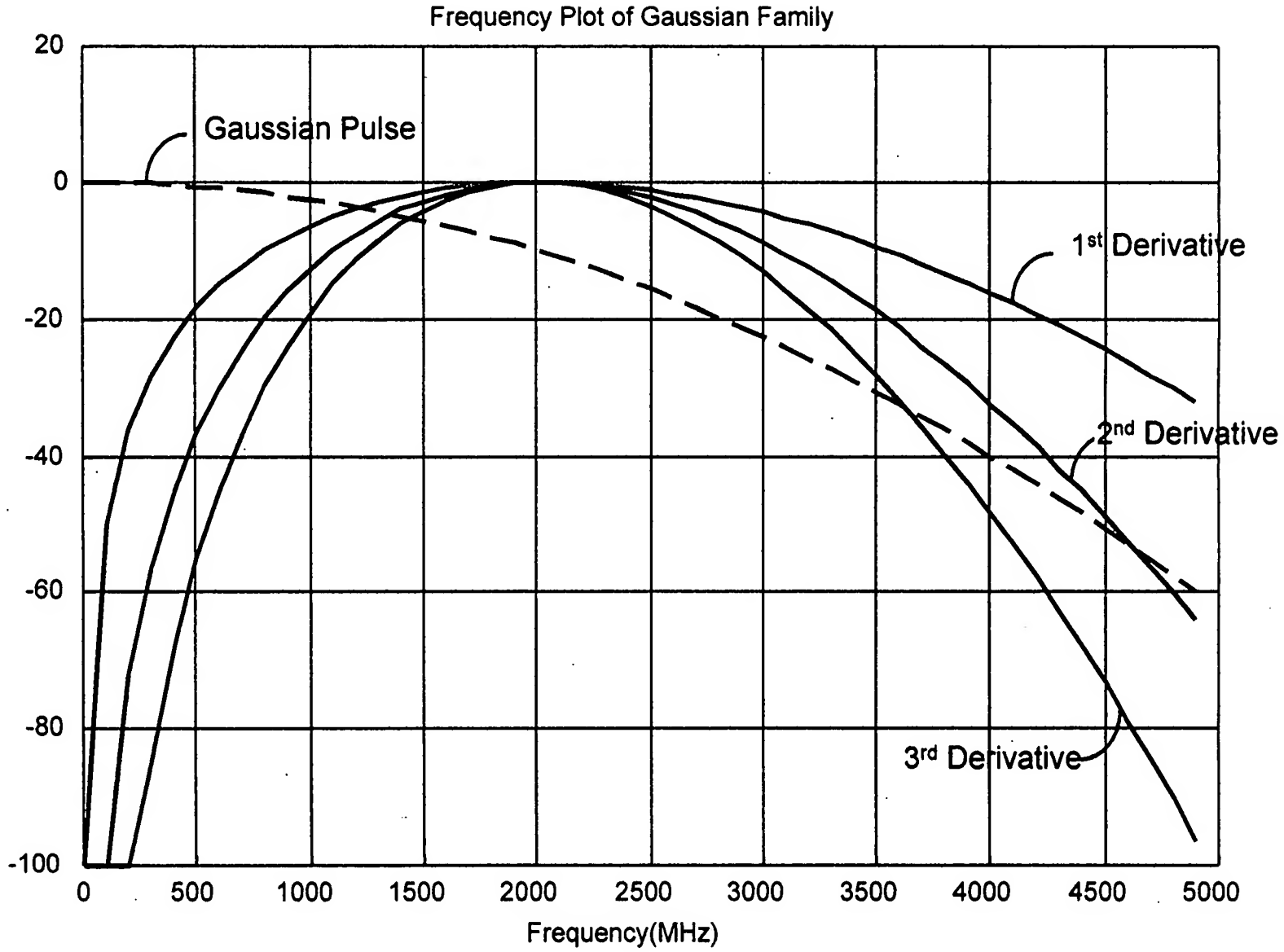

Frequency Plot of Gaussian Family
20
0
-20
-40
-60
-80
-100
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Frequency(MHz)
Gaussian Pulse
1st Derivative
2nd Derivative
3rd Derivative

FIG. 1F

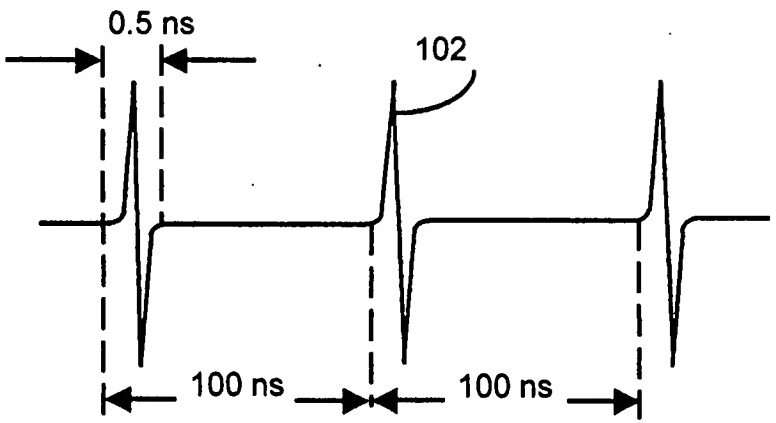


FIG. 2A

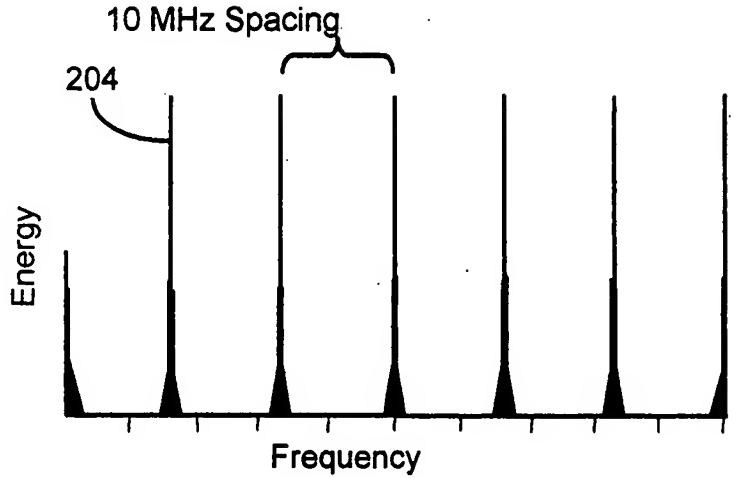


FIG. 2B

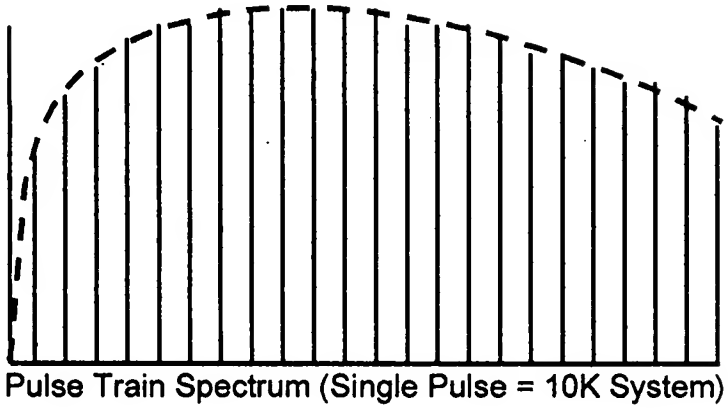


FIG. 2C

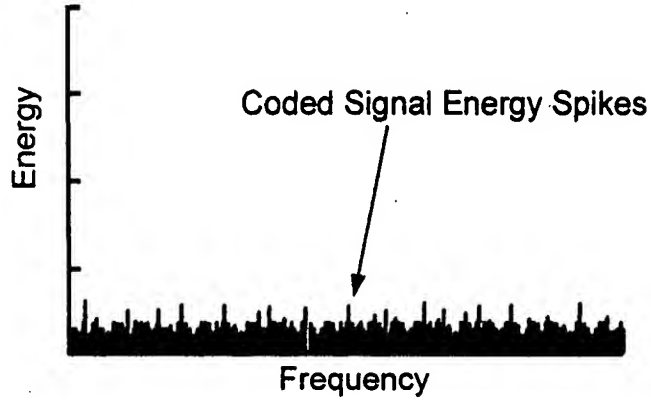


FIG. 2D

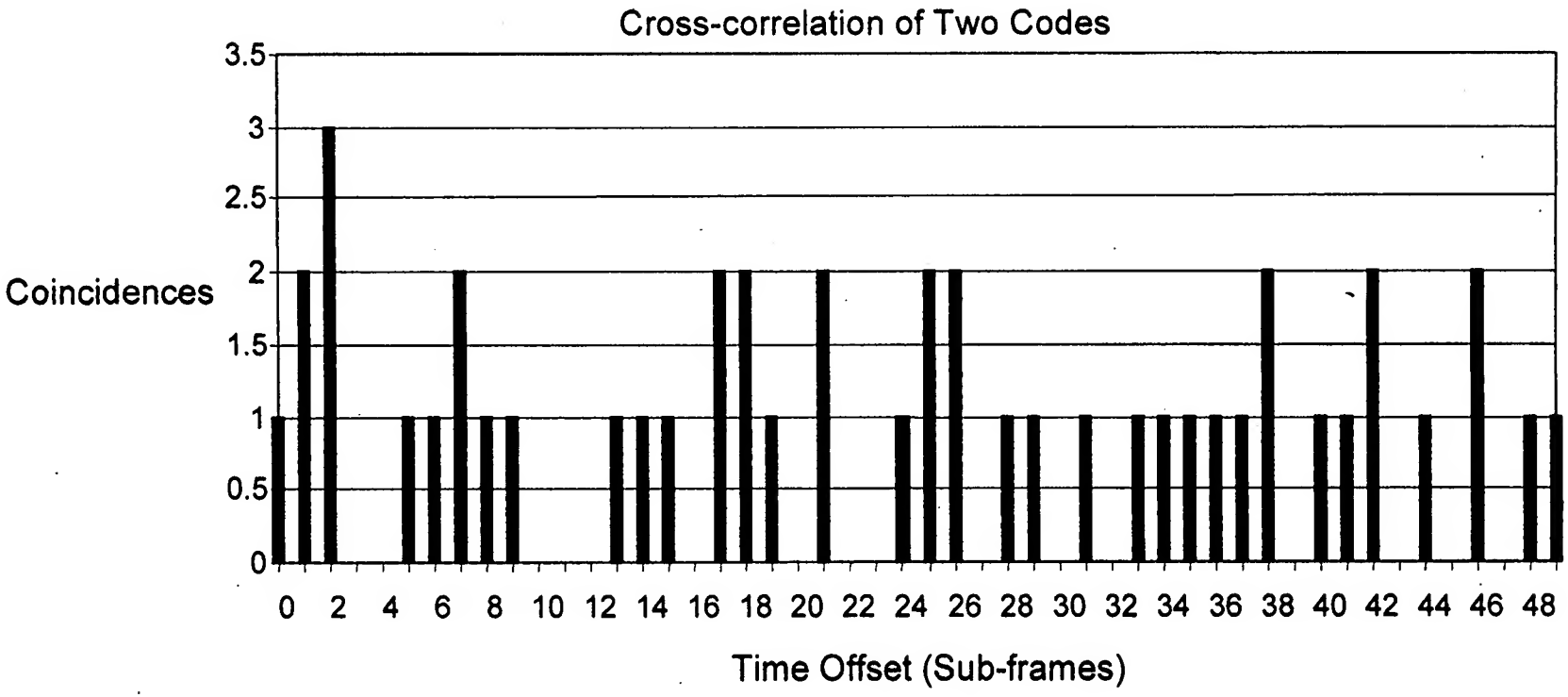
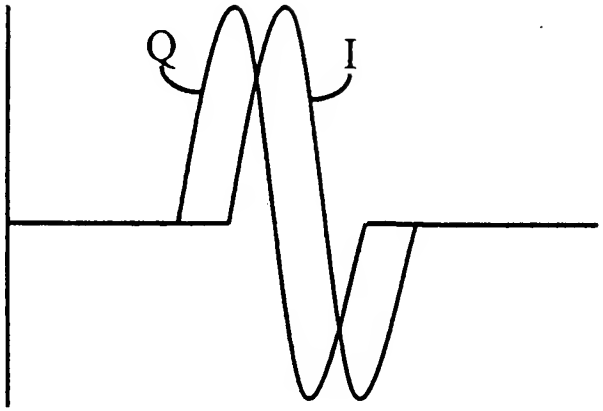
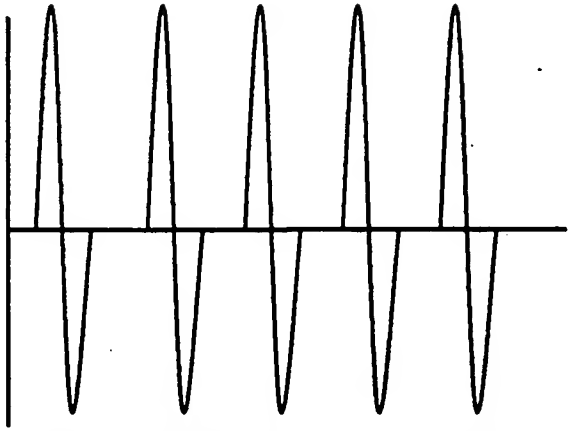

Cross-correlation of Two Codes
Coincidences
3.5
3
2.5
2
1.5
1
0.5
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Time Offset (Sub-frames)

FIG. 3



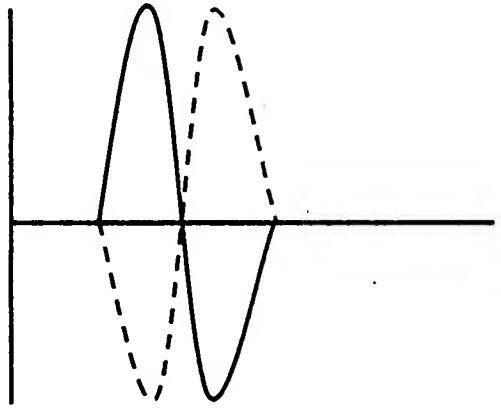
Early – Late Modulation

FIG. 4A



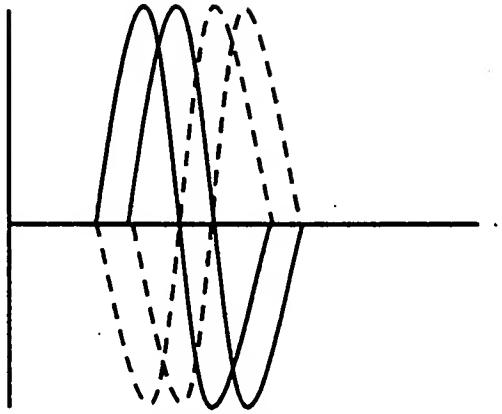
One of Many Modulation

FIG. 4B



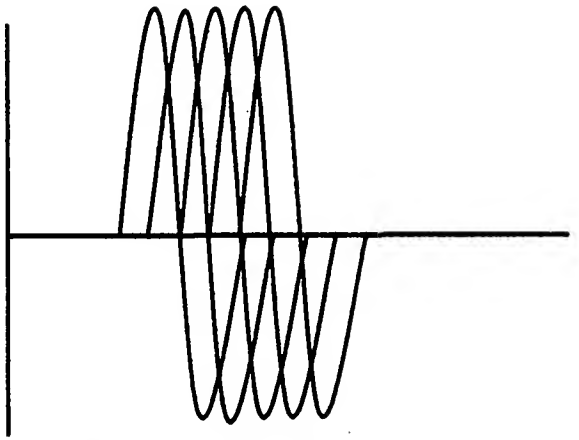
Flip Modulation

FIG. 4C



Quad Flip Modulation

FIG. 4D



Vector Modulation

FIG. 4E

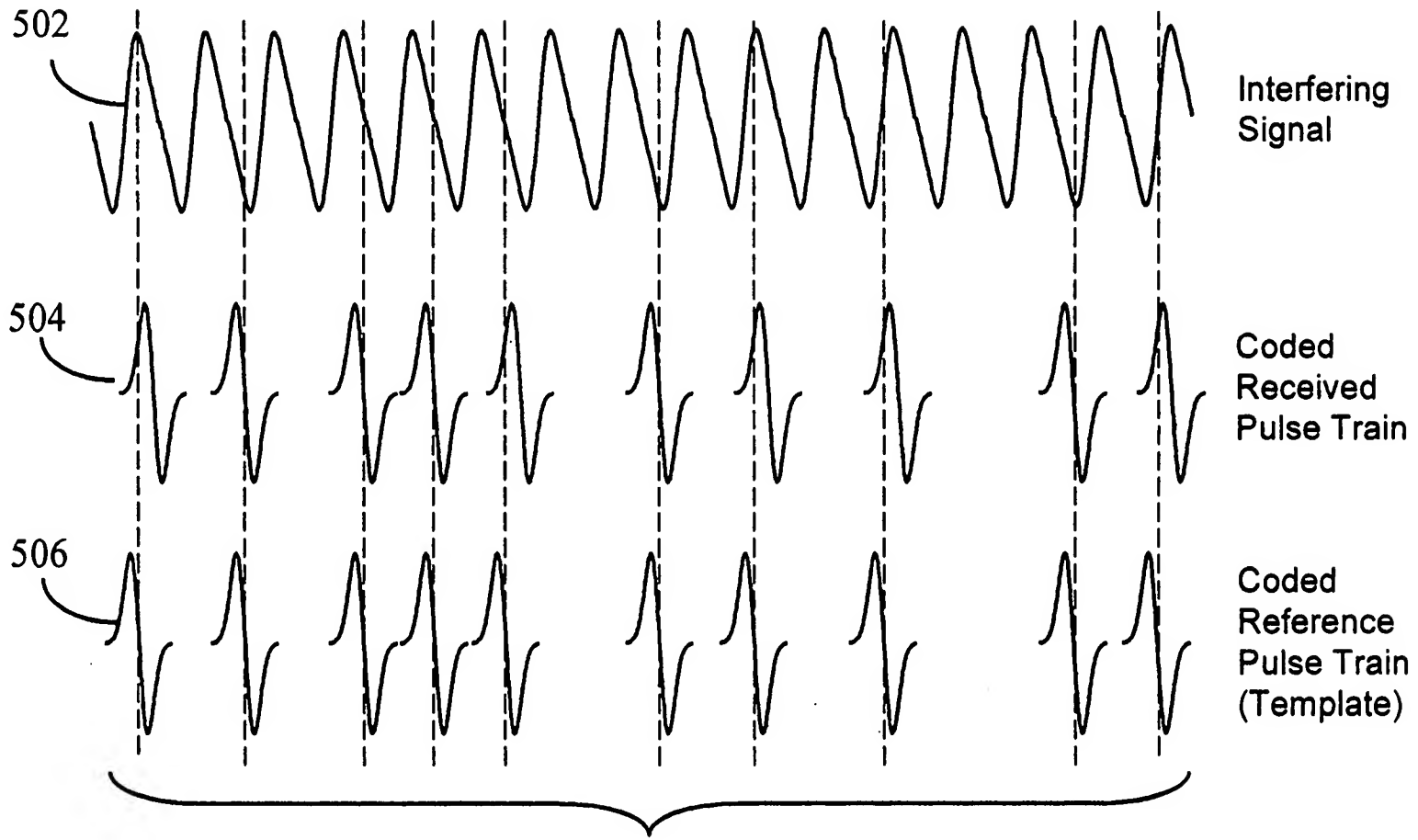

502
Interfering Signal
504
Coded Received Pulse Train
506
Coded Reference Pulse Train (Template)

FIG. 5A

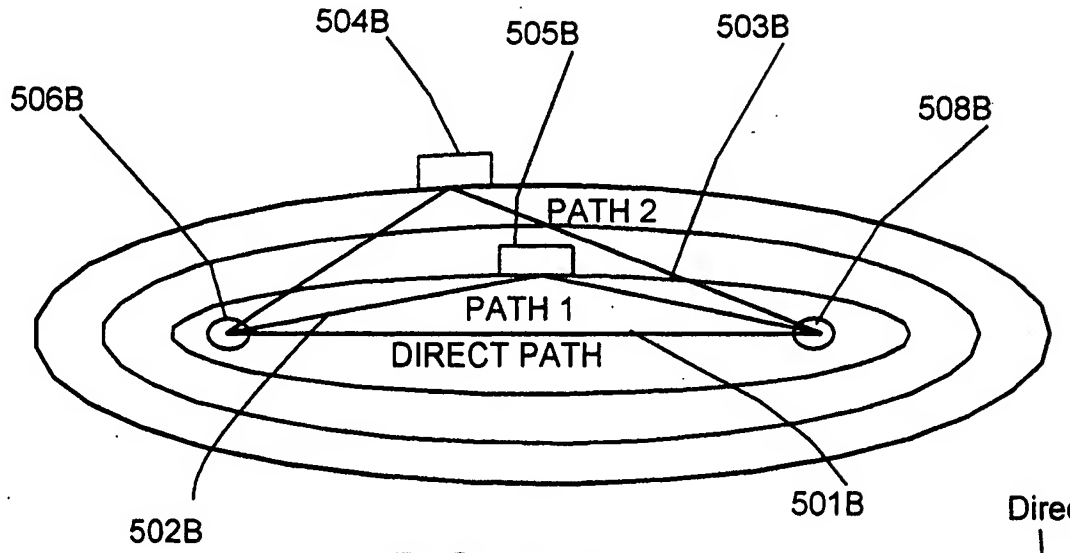

504B
505B
503B
506B
508B
PATH 2
PATH 1
DIRECT PATH
502B
501B

FIG. 5B

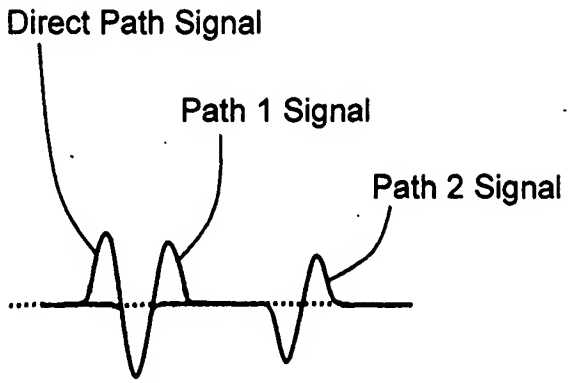

Direct Path Signal
Path 1 Signal
Path 2 Signal
Constructive
Non-Interfering

FIG. 5C

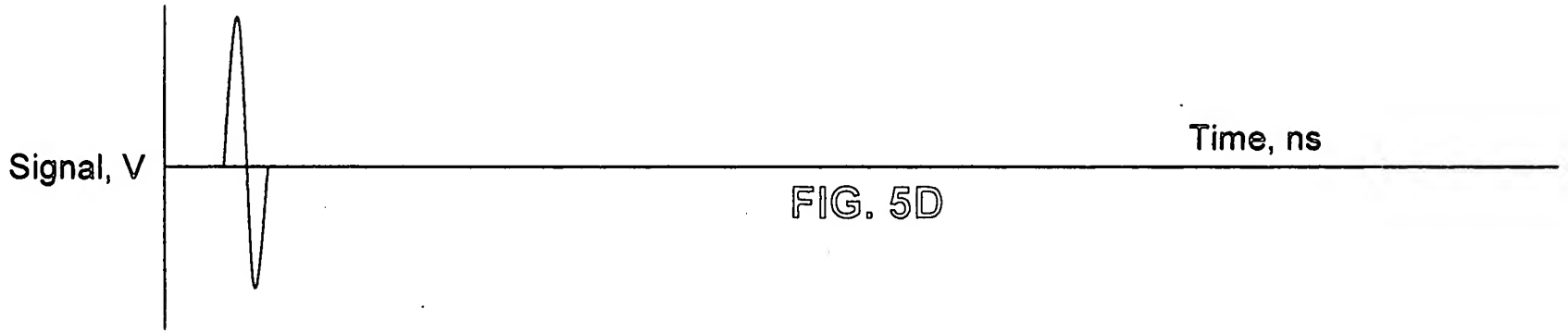


FIG. 5D

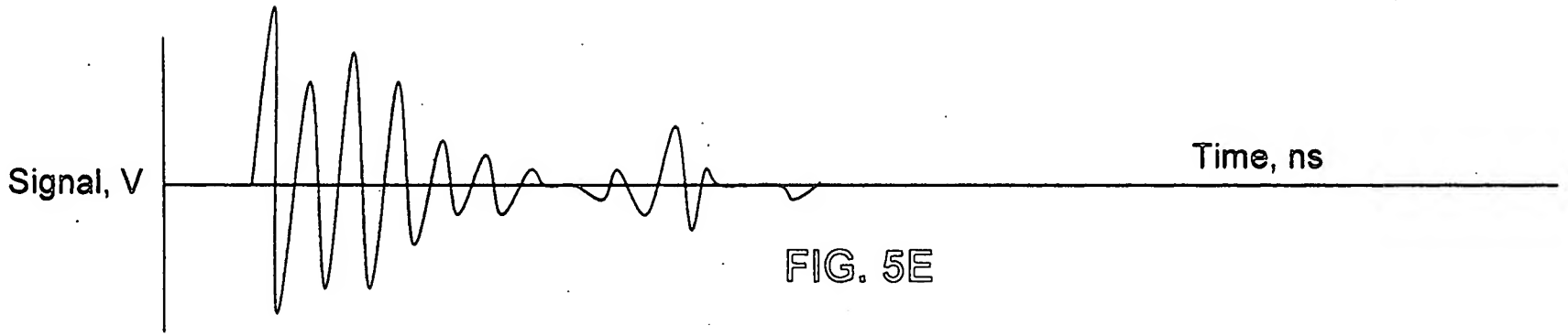


FIG. 5E

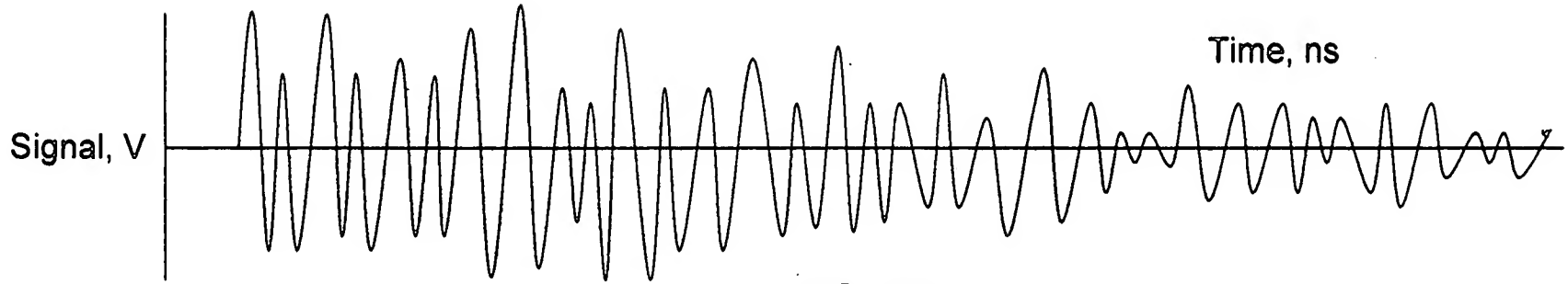


FIG. 5F

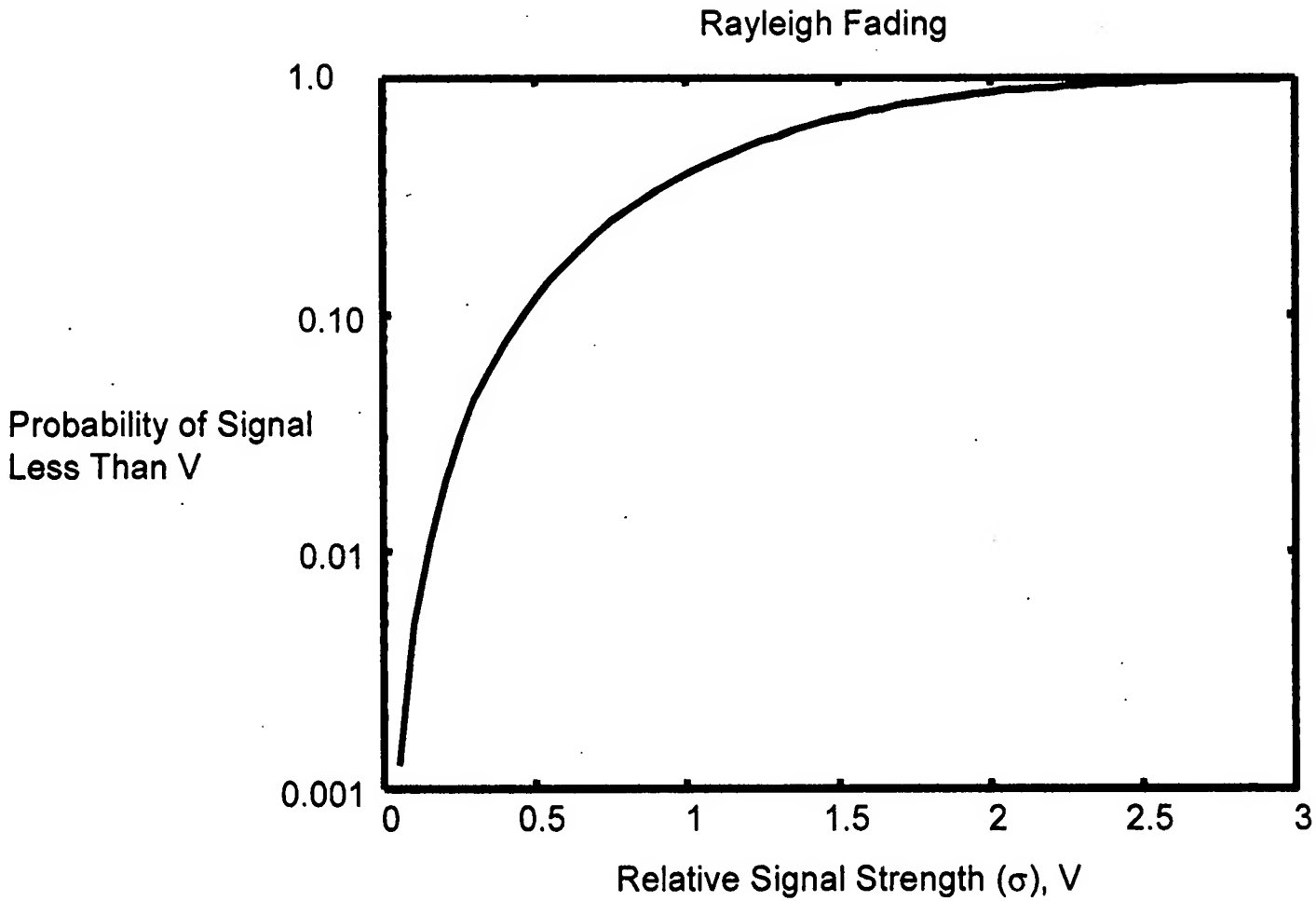

Rayleigh Fading
1.0
0.10
0.01
0.001
Probability of Signal
Less Than V
0
0.5
1
1.5
2
2.5
3
Relative Signal Strength (σ), V

Fig. 5G

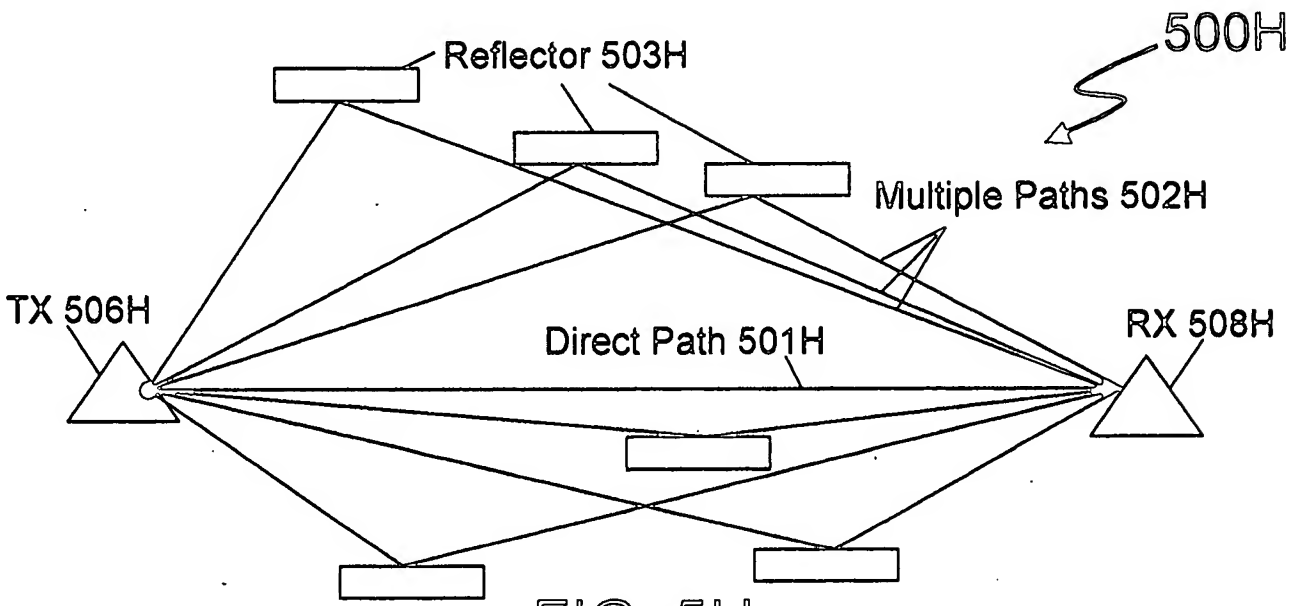

500H
Reflector 503H
Multiple Paths 502H
TX 506H
Direct Path 501H
RX 508H

FIG. 5H

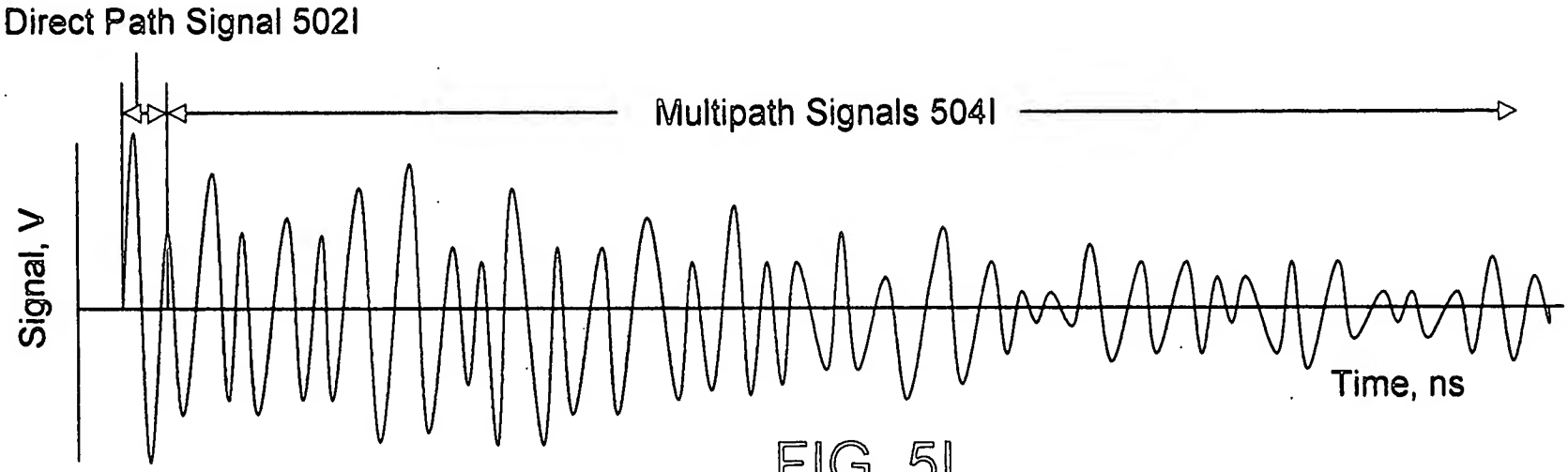

Direct Path Signal 502I
Multipath Signals 504I
Signal, V
Time, ns

FIG. 5I

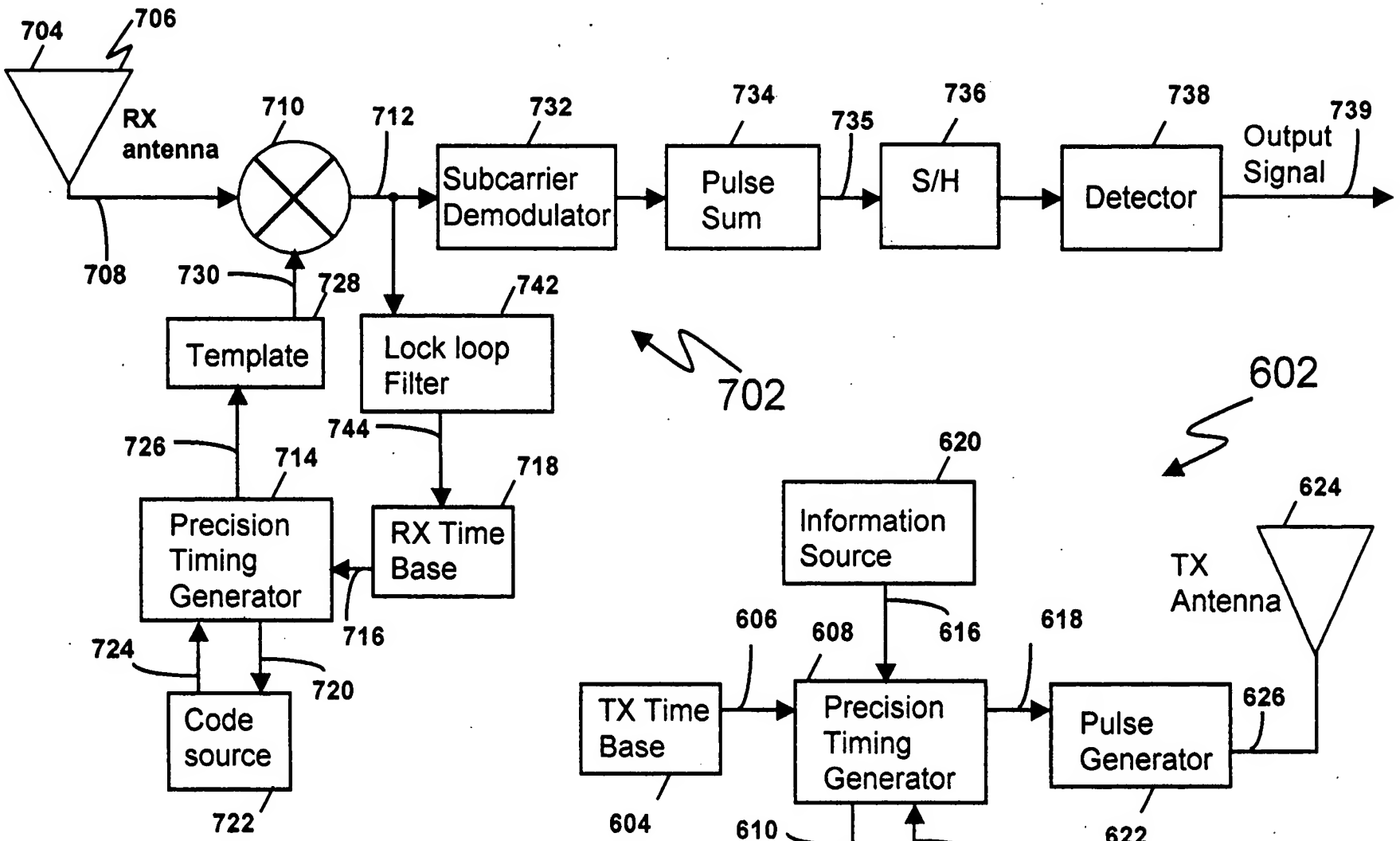

704
706
RX antenna
710
712
732
734
735
736
738
739
Output Signal
Subcarrier Demodulator
Pulse Sum
S/H
Detector
708
730
728
742
Template
Lock loop Filter
702
744
726
714
718
Precision Timing Generator
RX Time Base
716
724
720
Code source
722

FIG. 7

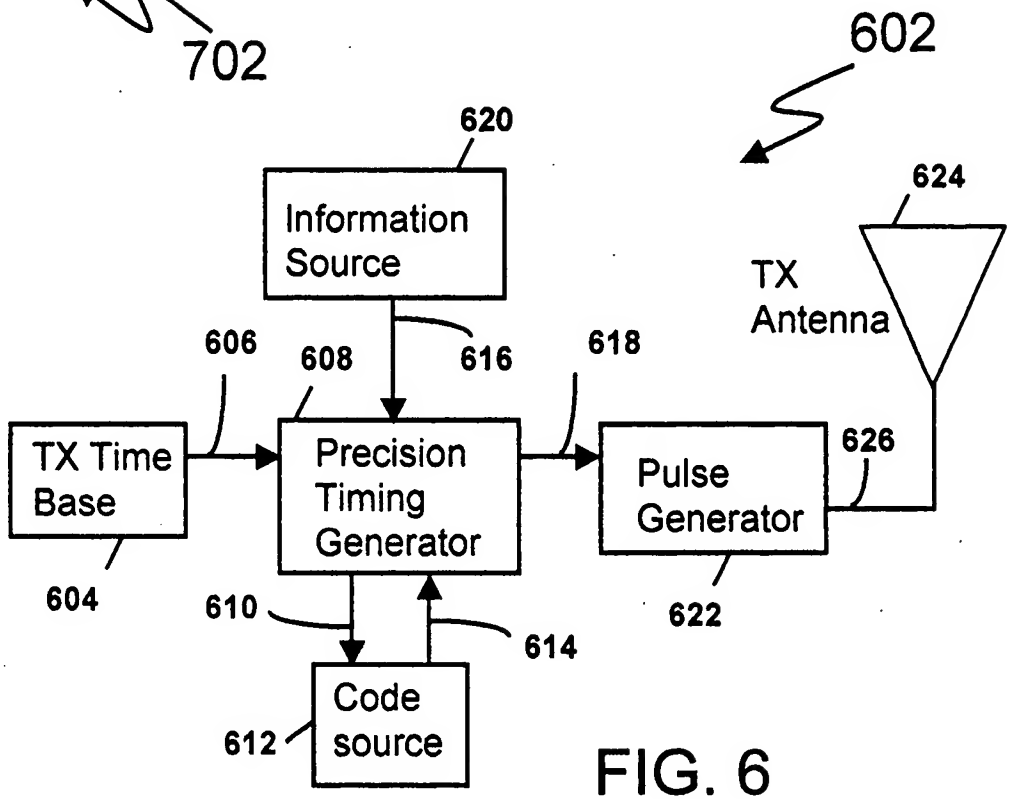

602
620
624
Information Source
TX Antenna
606
608
616
618
TX Time Base
Precision Timing Generator
Pulse Generator
626
604
610
614
622
Code source
612

FIG. 6

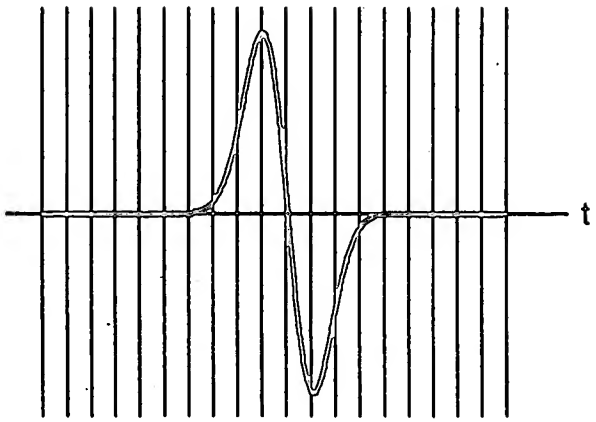


FIG. 8A

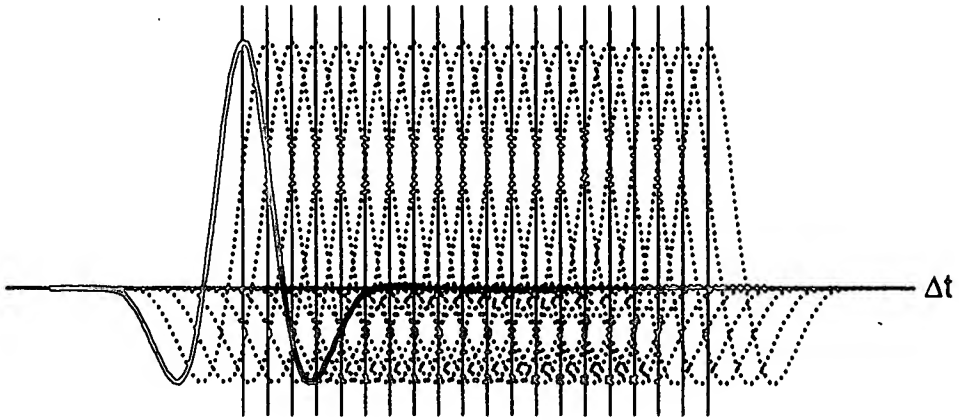


FIG. 8B

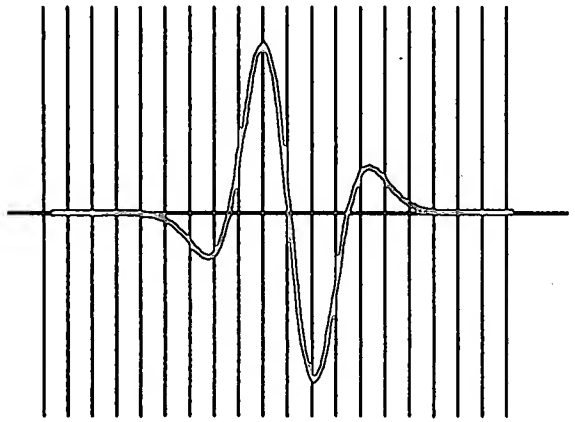


FIG. 8C

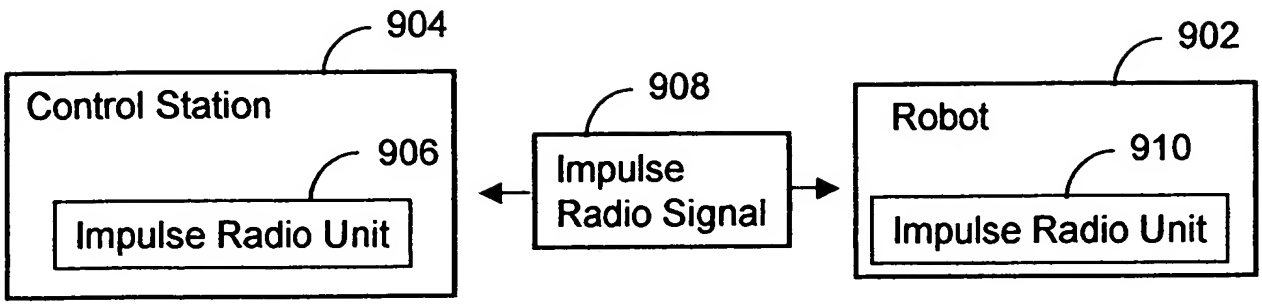

904
Control Station
906
Impulse Radio Unit
908
Impulse
Radio Signal
902
Robot
910
Impulse Radio Unit

Fig.9

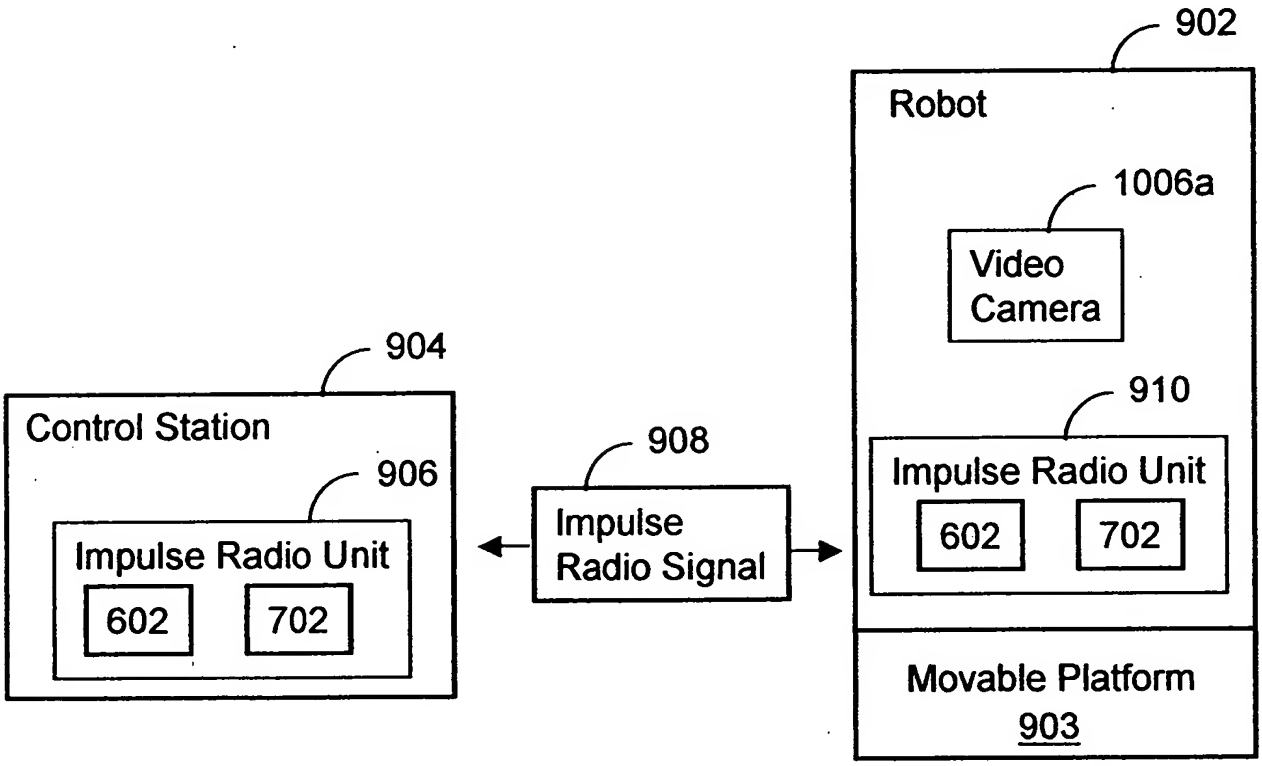

902
Robot
1006a
Video
Camera
910
Impulse Radio Unit
602
702
904
Control Station
906
Impulse Radio Unit
602
702
908
Impulse
Radio Signal
Movable Platform
903

Fig.10

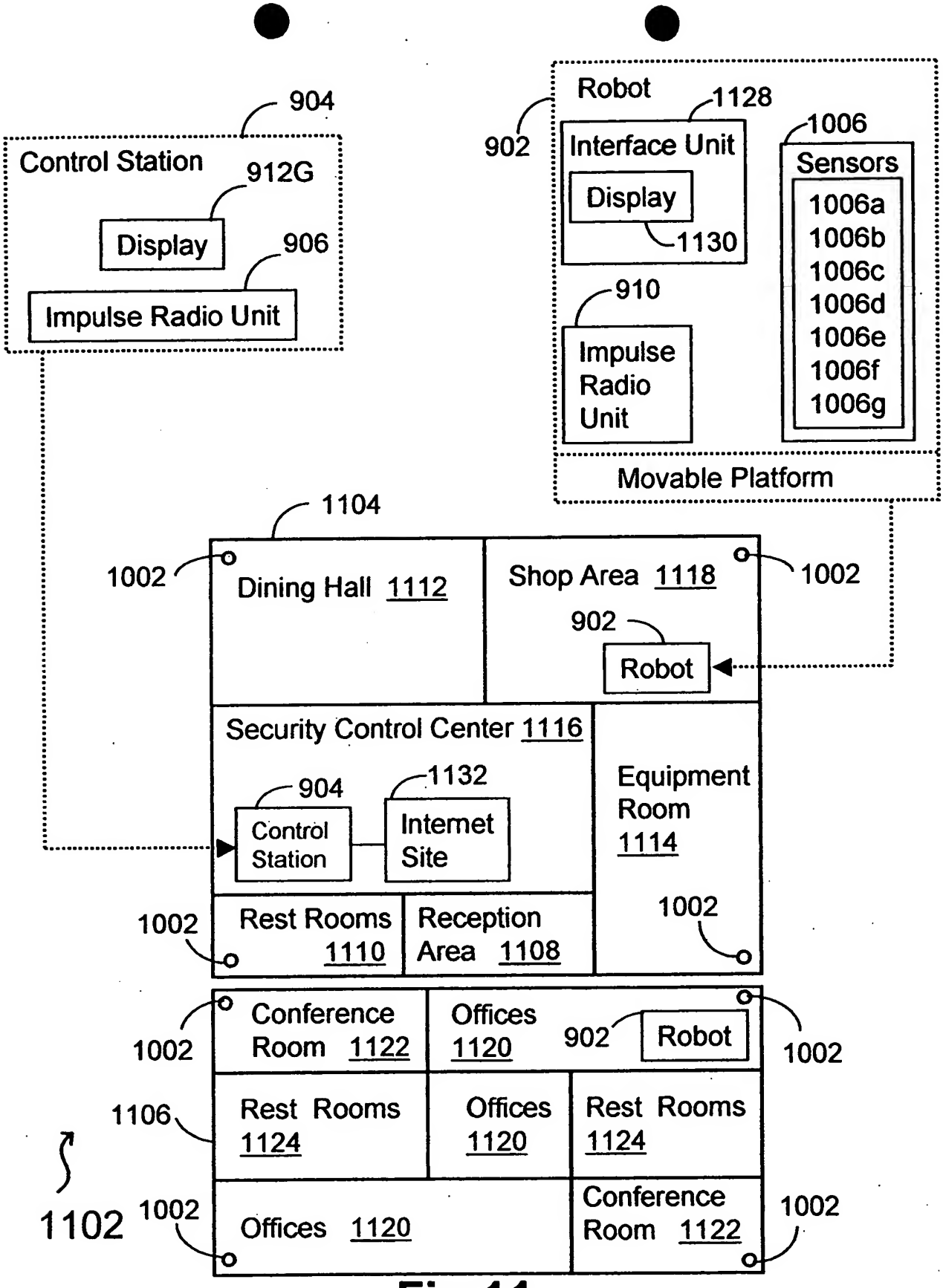

Control Station
904
912G
Display
906
Impulse Radio Unit
Robot
902
1128
Interface Unit
Display
1130
1006
Sensors
1006a
1006b
1006c
1006d
1006e
1006f
1006g
910
Impulse Radio Unit
Movable Platform
1104
1002
Dining Hall 1112
Shop Area 1118
1002
902
Robot
Security Control Center 1116
904
Control Station
1132
Internet Site
Equipment Room 1114
1002
Rest Rooms 1110
Reception Area 1108
1002
Conference Room 1122
Offices 1120
902
Robot
1002
1106
Rest Rooms 1124
Offices 1120
Rest Rooms 1124
1102
1002
Offices 1120
Conference Room 1122
1002

Fig.11

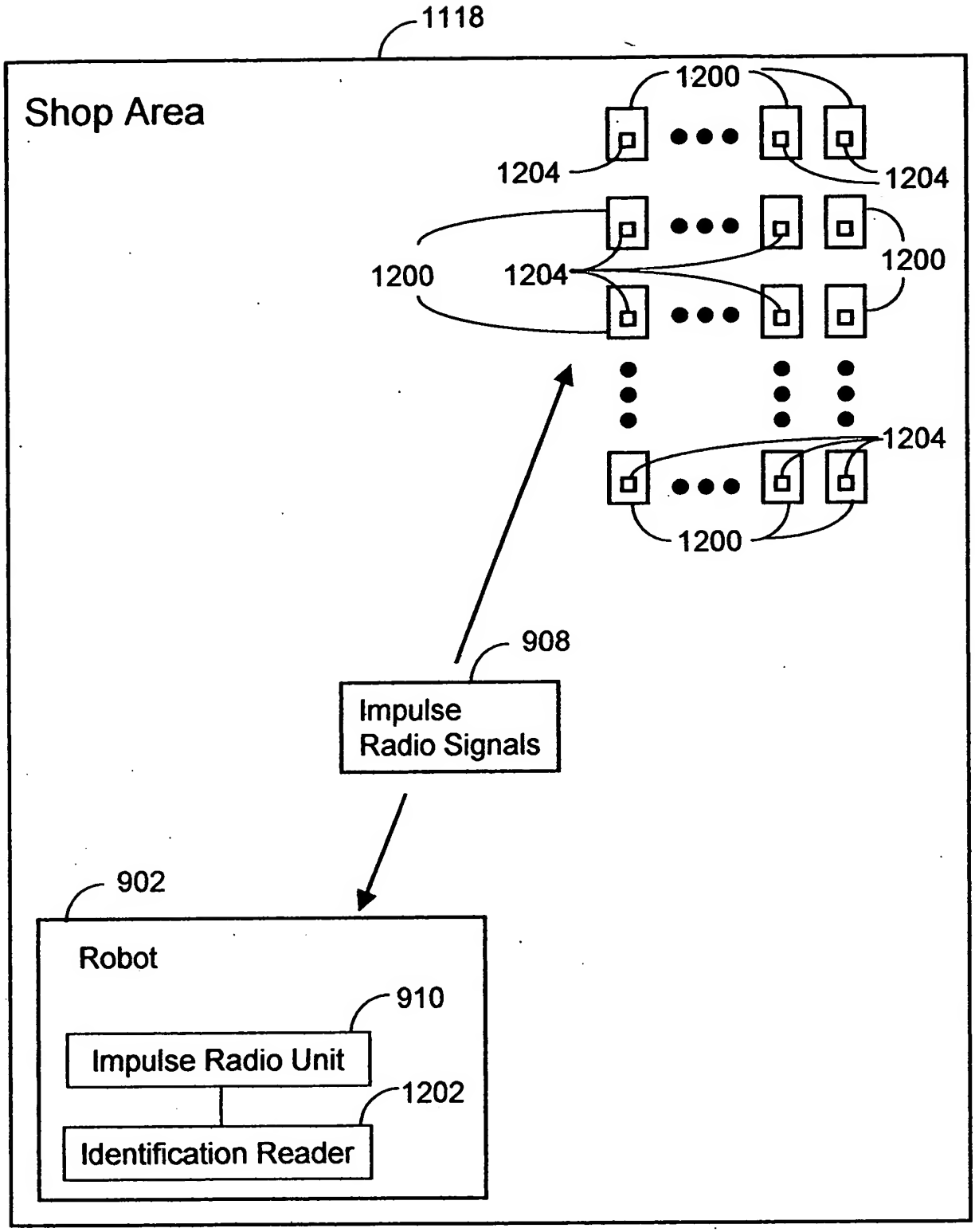

1118
Shop Area
1200
1204
1204
1200
1204
1200
1204
1200
908
Impulse
Radio Signals
902
Robot
910
Impulse Radio Unit
1202
Identification Reader

Fig.12

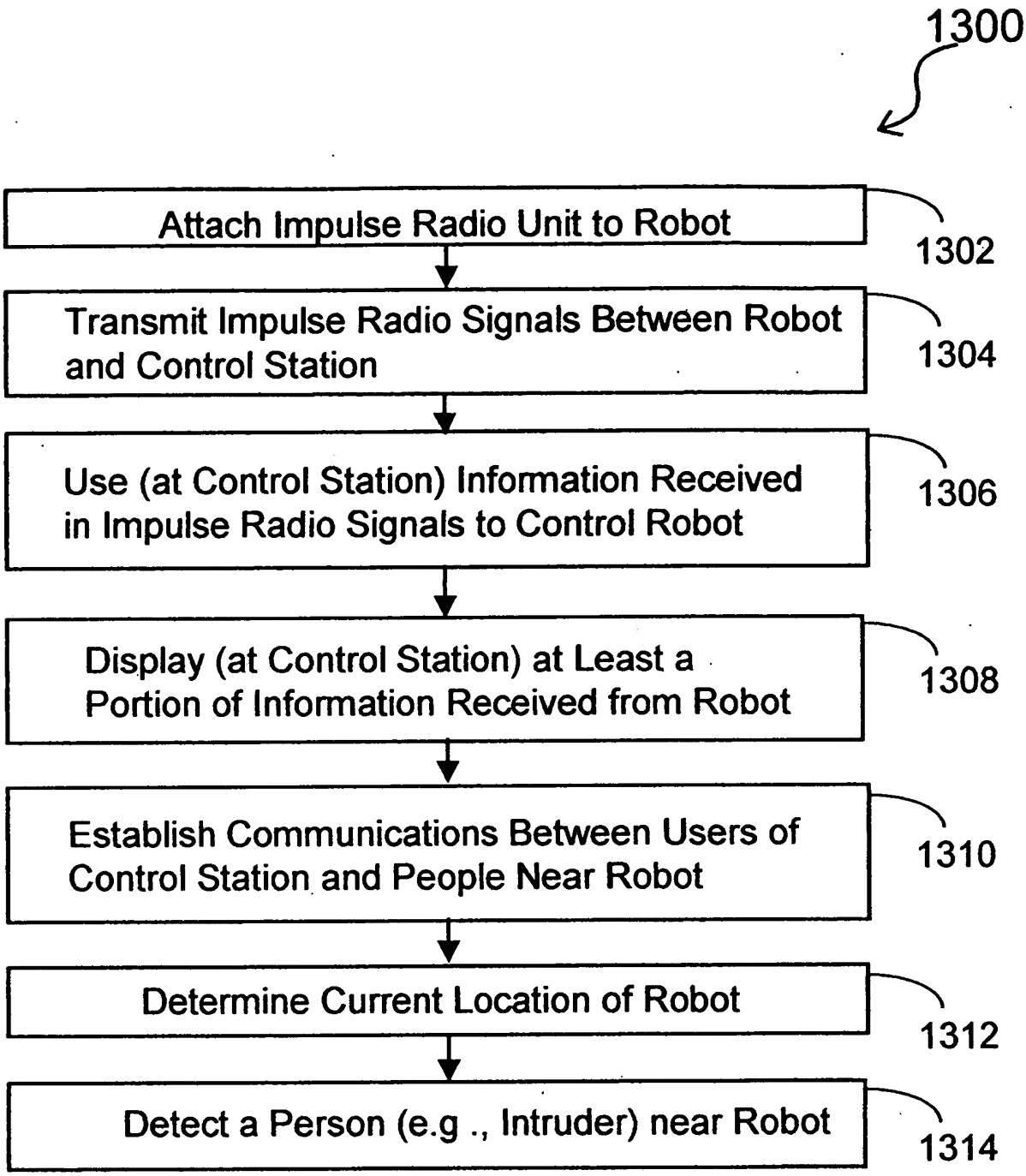

1300
Attach Impulse Radio Unit to Robot
1302
Transmit Impulse Radio Signals Between Robot and Control Station
1304
Use (at Control Station) Information Received in Impulse Radio Signals to Control Robot
1306
Display (at Control Station) at Least a Portion of Information Received from Robot
1308
Establish Communications Between Users of Control Station and People Near Robot
1310
Determine Current Location of Robot
1312
Detect a Person (e.g ., Intruder) near Robot
1314

Fig.13

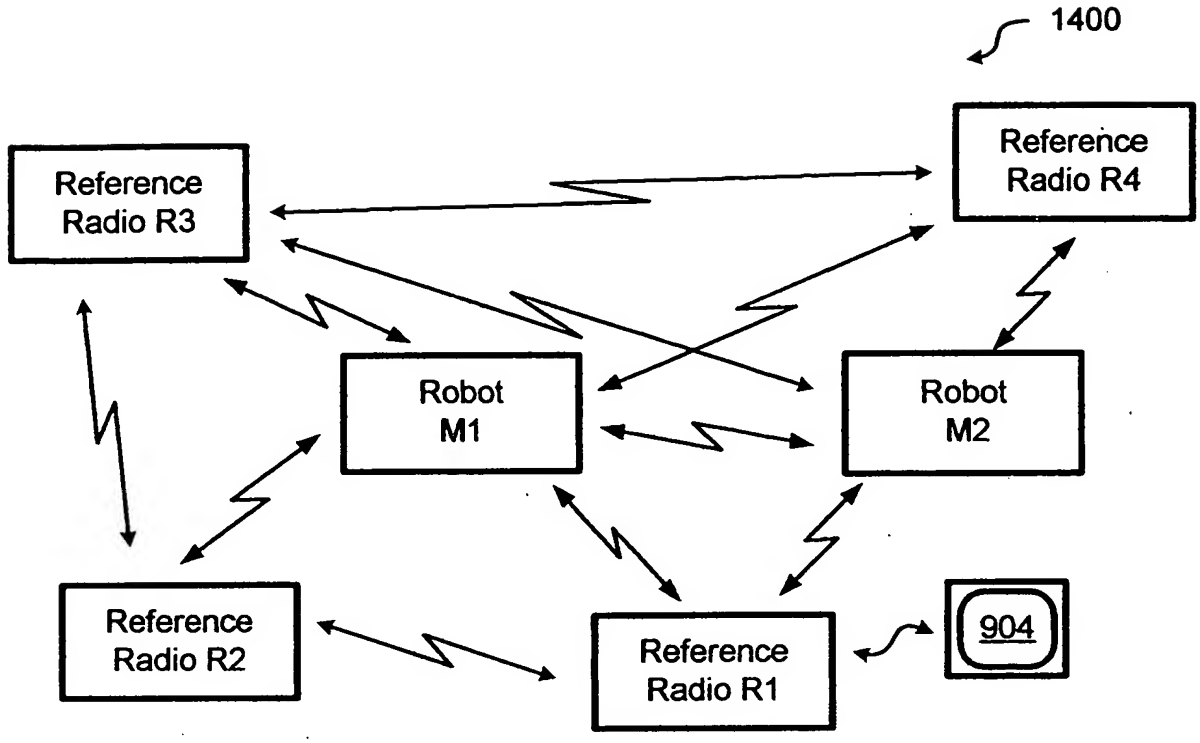

1400
Reference Radio R3
Reference Radio R4
Robot M1
Robot M2
Reference Radio R2
Reference Radio R1
904

FIG. 14

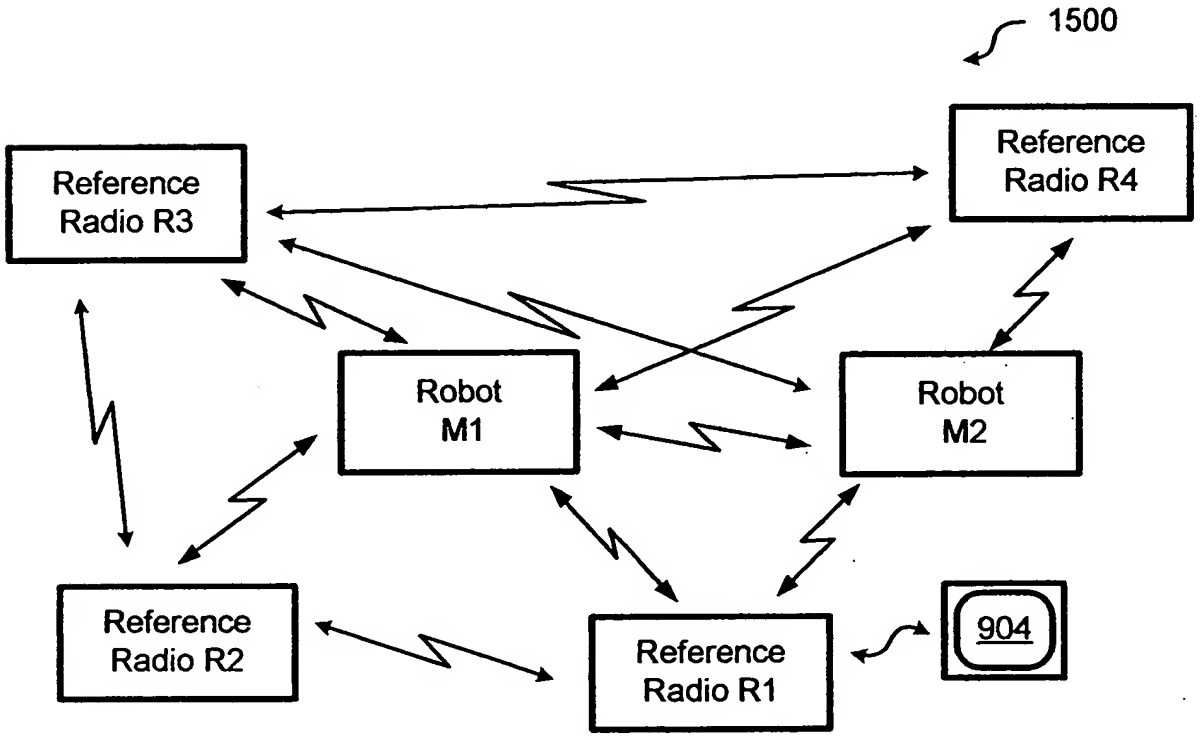

1500
Reference Radio R3
Reference Radio R4
Robot M1
Robot M2
Reference Radio R2
Reference Radio R1
904

FIG. 15

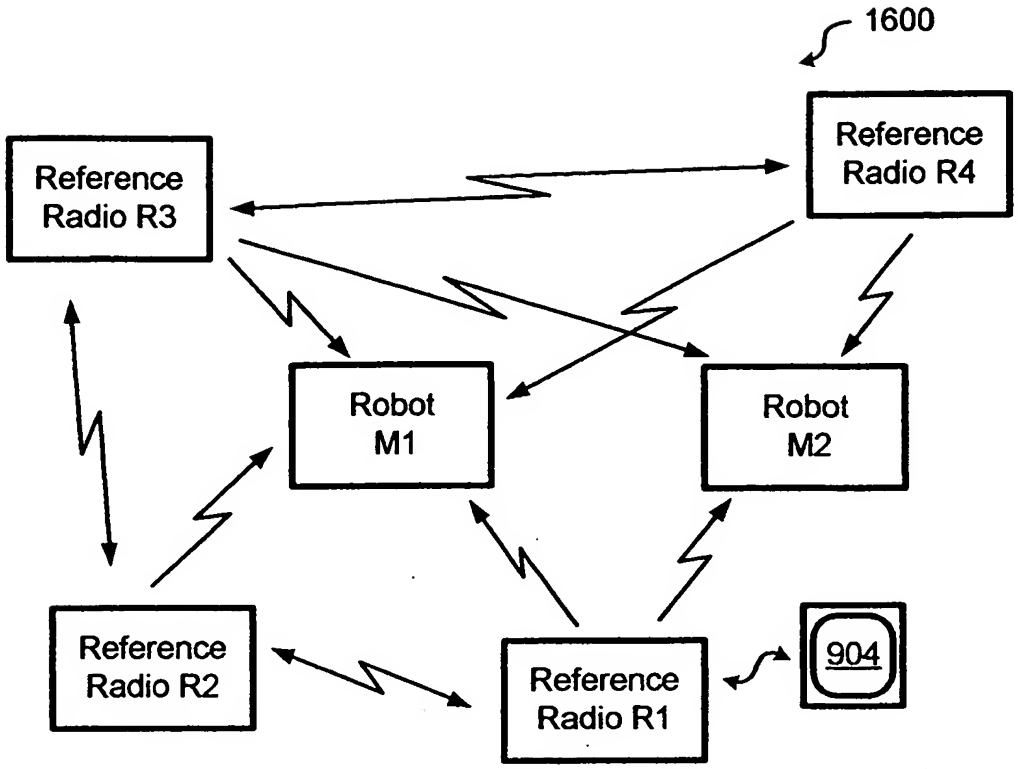

1600
Reference Radio R4
Reference Radio R3
Robot M1
Robot M2
Reference Radio R2
Reference Radio R1
904

FIG. 16

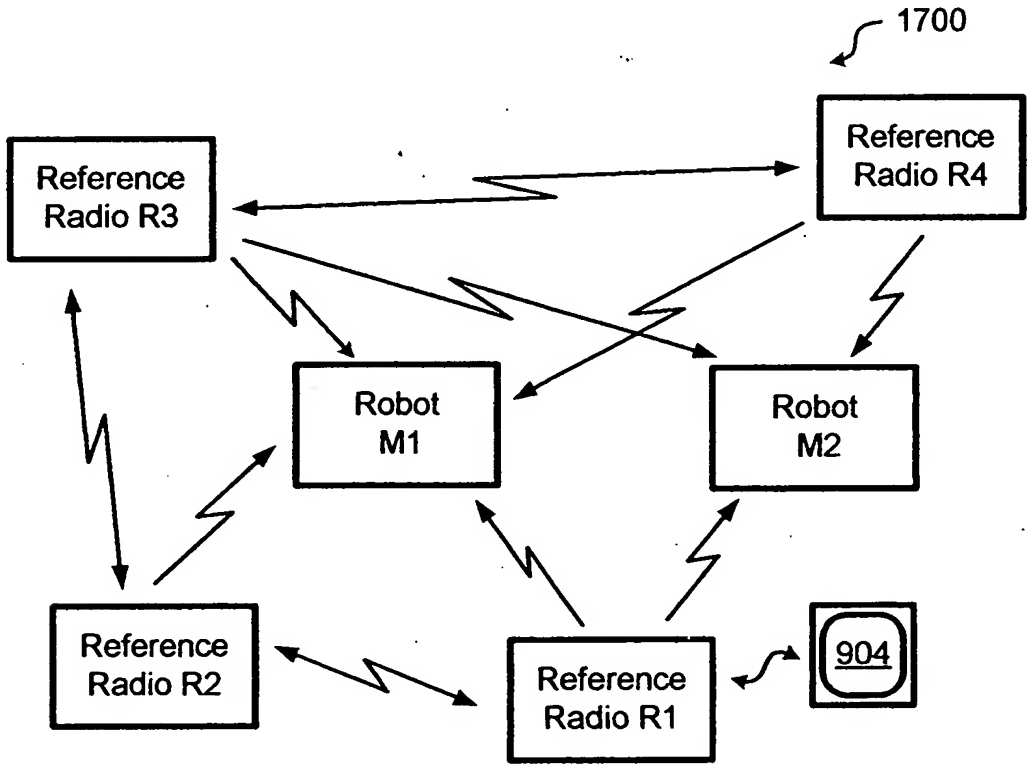

1700
Reference Radio R4
Reference Radio R3
Robot M1
Robot M2
Reference Radio R2
Reference Radio R1
904

FIG. 17

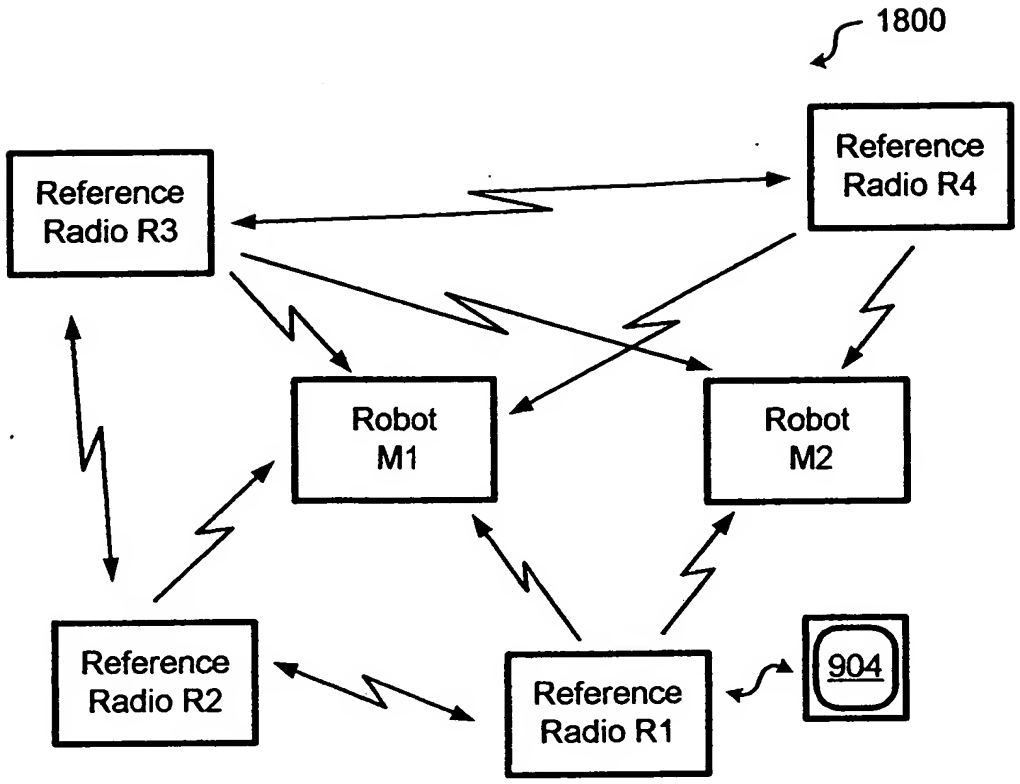

1800
Reference Radio R4
Reference Radio R3
Robot M1
Robot M2
Reference Radio R2
Reference Radio R1
904

FIG. 18

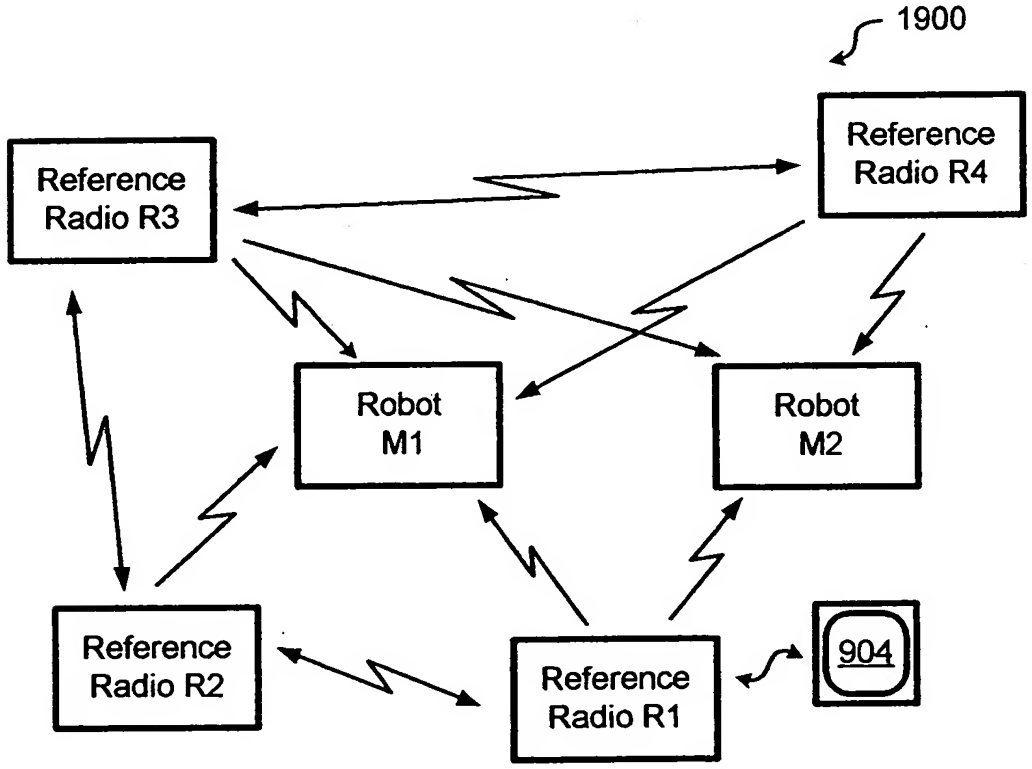

1900
Reference Radio R4
Reference Radio R3
Robot M1
Robot M2
Reference Radio R2
Reference Radio R1
904

FIG. 19

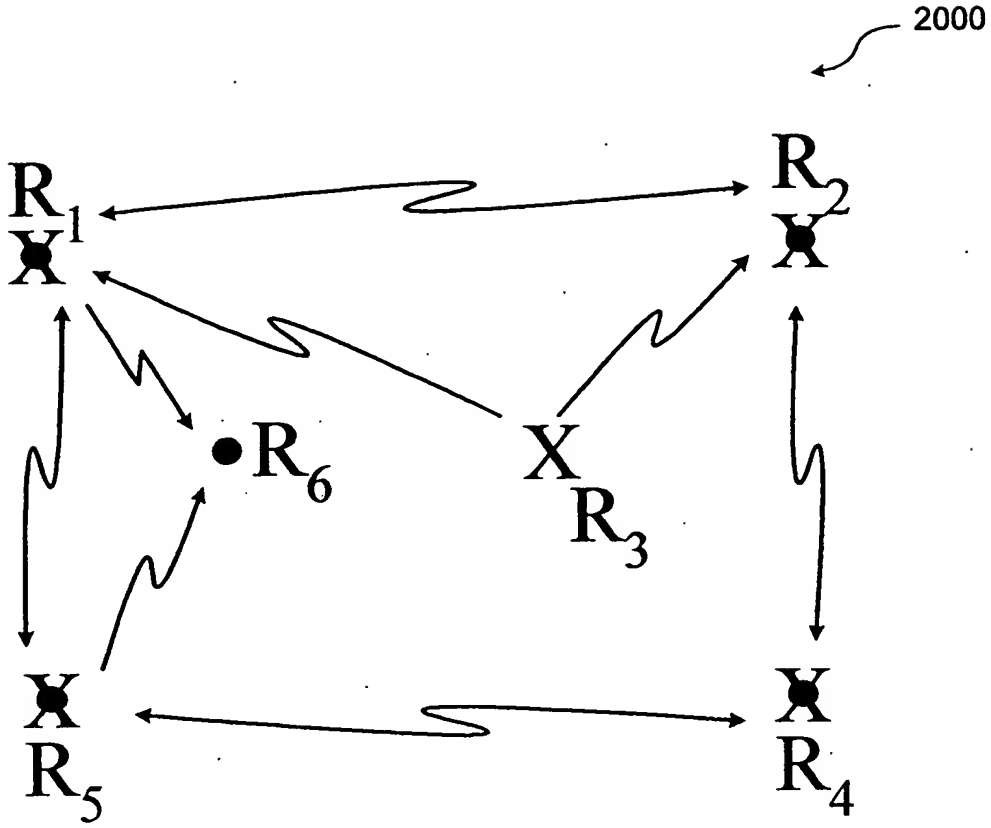


Fig. 20

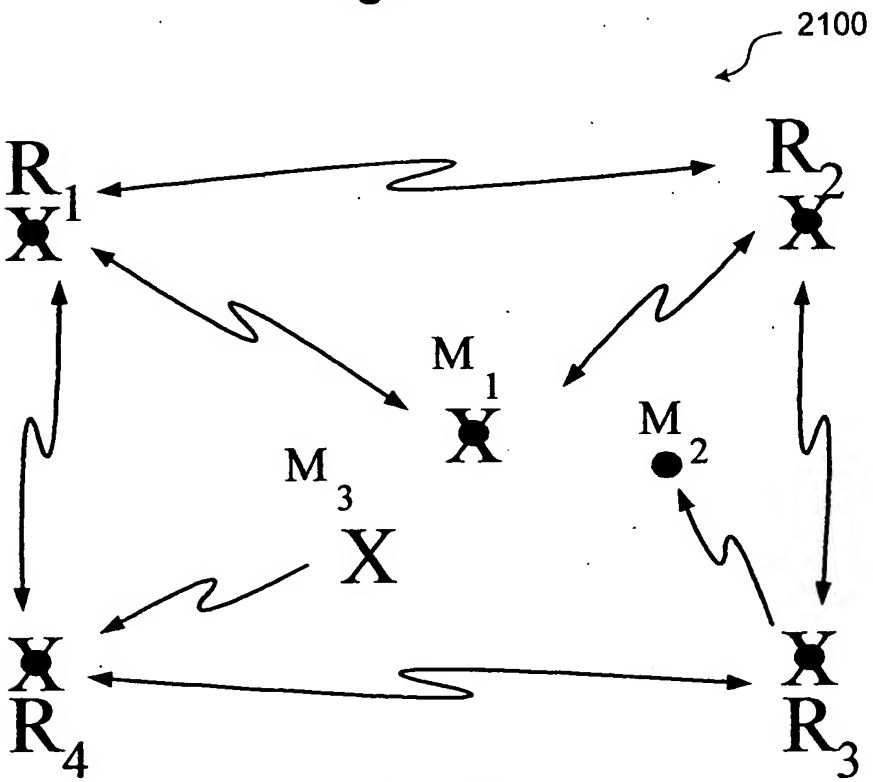


Fig. 21

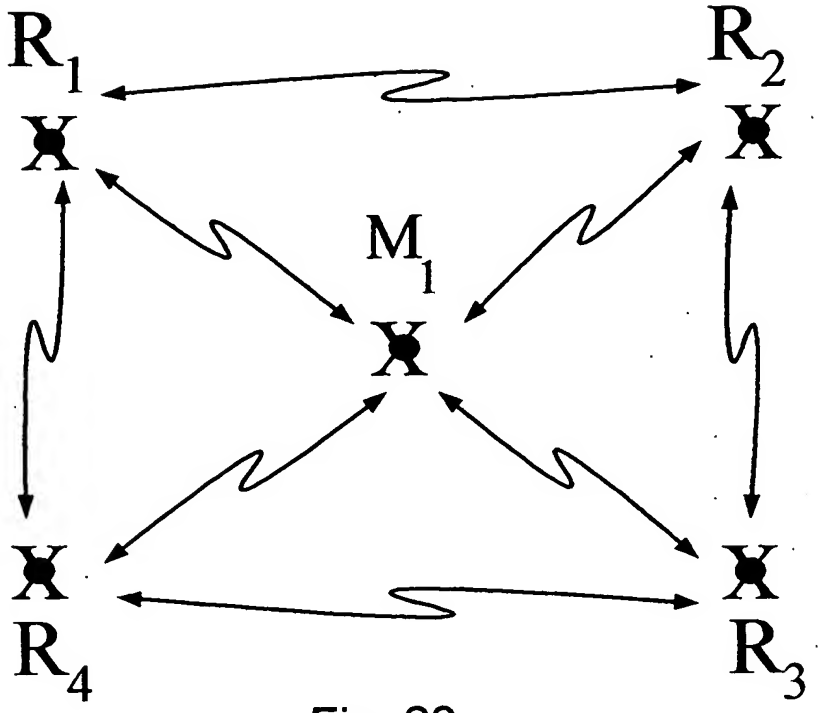


Fig. 22

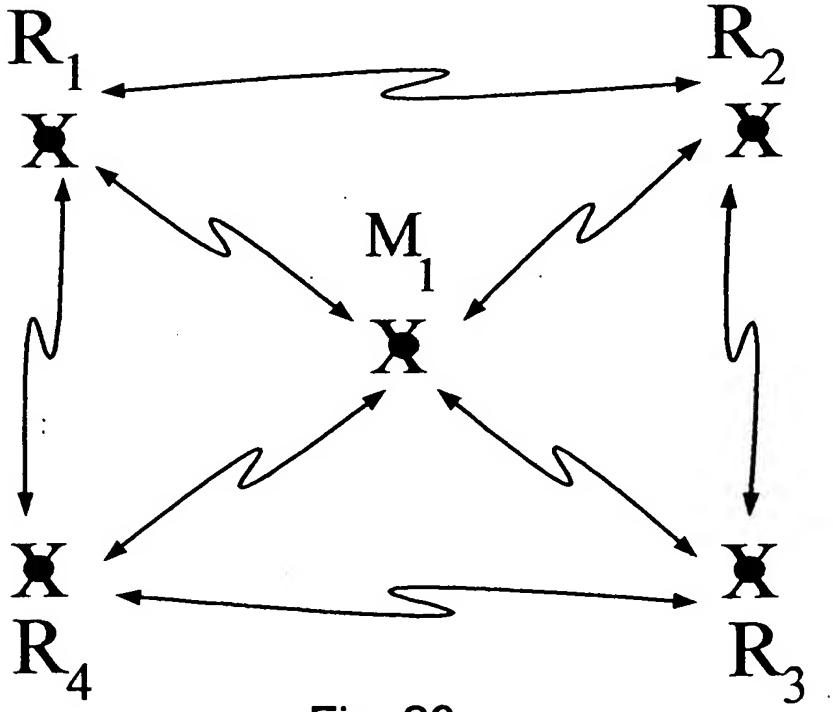


Fig. 23

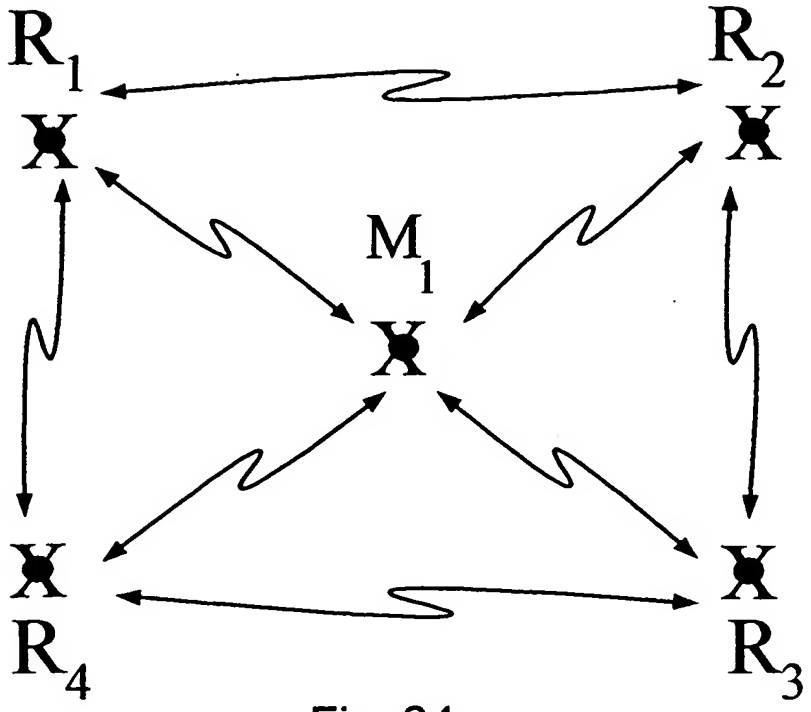


Fig. 24

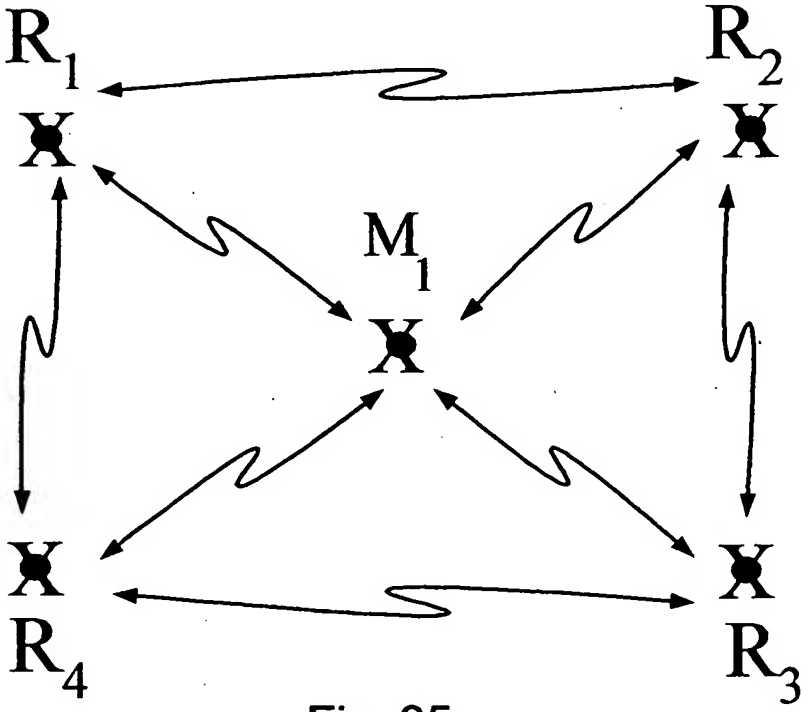


Fig. 25